NOTE ON THE KAPITI PHONOLITES AND KENYTES OF KENYA COLONY

By W. CAMPBELL SMITH

With new chemical analyses by MAX. H. HEY

(*With Plates 1 and 2*)

SYNOPSIS

The Kapitian is the oldest series of rocks in the volcanic succession of the East African Rift Valley. Its dominant lava is a phonolite (Kapiti type). In the field it is distinct from the kenytes of the stratigraphically later (i.e. younger) Mt. Kenya Volcanic Suite. Under the microscope, however, it is found that holocrystalline examples of the kenytes are very similar to the Kapiti phonolites. Chemical analysis of a typical Kapiti phonolite shows a high water-content (3·31 per cent.), and thin sections reveal the presence of analcime in the groundmass. Otherwise there is little mineralogical difference between the two rocks. There are differences in texture, but these are not easily expressed in definitions. The name 'Kenyte' was first used by J. W. Gregory for the lavas around the central plug of Mt. Kenya, of which black glass and large anorthoclase crystals are the most conspicuous constituents in hand-specimens. These glassy types of the kenytes are quite distinct from the Kapiti phonolites.

In the volcanic succession of East Africa the oldest of the series of lavas is that named by Professor J. W. Gregory the Kapitian Series, typically developed in the Kapiti Plains of Kenya Colony. The predominant lava in this series is a dark porphyritic phonolite with large white phenocrysts of feldspar and scarcer, usually smaller, phenocrysts of nepheline in a dark base. Gregory considered that the presence of phenocrysts of these *two* minerals gave the rock a distinctive appearance unlike any other East African lava (Gregory, 1921: 193).

In a paper published in 1931 on 'A classification of some rhyolites, trachytes, and phonolites from part of Kenya Colony . . .' a detailed petrographic description was given of phonolites of the Kapitian Series, chiefly collected by J. W. Gregory in 1893, and in the same paper the kenytes of Mt. Kenya were fully described for the first time. The chief point of interest in the description of the kenytes was that, in addition to the already well-known phenocrysts of anorthoclase, they contained also phenocrysts of nepheline, the presence of which had not previously been recorded (Campbell Smith, 1931: 242). Thus both the kenytes of Mt. Kenya and the phonolites of the Kapitian Series show phenocrysts of nepheline and feldspar in a dark base, and might be very similar in appearance in hand-specimen and not always so readily distinguished as Professor Gregory had supposed.

How close this resemblance between the two types of rock may be is emphasized by the discovery that the rock selected for chemical analysis as representative of the Kapitian phonolites (Campbell Smith, 1931: 239) and taken by Gregory to belong to the Kapitian Series 'is a kenyte of the Mount Kenya Suite and has no connexion with the Kapiti phonolites . . .' (Shackleton, 1945: 16).

The rock specimen in question [GN417][1] was collected by J. W. Gregory in 1919 from north-east of the Amboni River, 7 miles north-east of Nyeri (Gregory, 1921: 142, 196). The locality is near Songari Hill on the eastern edge of the map accompanying Professor Shackleton's report quoted above. In the 1931 paper referred to above attention was drawn to the close resemblance of this rock in both hand-specimen and in sections to specimens of kenytes from Mt. Kenya and its description was kept separate from that of the rocks which represent the Kapitian phonolites collected by Gregory in 1893. It is now clear that the description of specimen GN417 and its chemical analysis apply to 'a kenyte of the Mount Kenya Suite' and not to a phonolite of the Kapitian Series, and that a new chemical analysis and additional petrographical descriptions of authentic specimens of phonolites of the Kapitian Series are required to re-establish their characters. An early opportunity was, therefore, sought to obtain fresh material of kenytes and Kapiti phonolites from the type areas, and Dr. K. P. Oakley of the Geological Department of the British Museum (Natural History) kindly undertook to collect suitable specimens in the course of his visit to Kenya Colony as a delegate to the Pan-African Congress on Prehistory in 1947.

The specimens of Kapiti phonolites collected by Dr. Oakley are from two localities: B.M. 1947, 200 (1) and (2), both from lat. 1° 40′ S., long. 36° 50′ 15″ E. on the Kapiti Plains, about 12 miles north-east of Kajiado Station; B.M. 1947, 200 (3), lat. 1° 50′ S., long. 36° 50′ E., near Cairn Hill, 6 miles east-north-east of Kajiado Station. All three specimens are good examples of the phonolite of the Kapitian Series. The first specimen [B.M. 1947, 200 (1)] was chosen for analysis as it was the largest and freshest specimen and provided plenty of material for sampling. Its petrographical description is given at the end of this paper. For the moment it will be sufficient to state that it appears to be exactly like the phonolite [GN250] collected by Gregory in 1919 at Kajiado, and this in turn corresponds exactly to the phonolite [G574] from Chanjavi (Ol Doinyo Sapuk, lat. 1° 10′ S., long. 30° 15′ E.) collected by Gregory in 1893 and described in the 1931 paper quoted above (p. 238). These rocks are recognized as typical of the predominant phonolites of the Kapitian Series.

Another phonolite very similar to the analysed specimen is one collected by Arthur Champion in 1912 from 'the pass over which runs the road from Ikutha to Kibwezi through the Yatta Plateau'. The phonolites of the Yatta Plateau form part of the Kapitian Series. They have recently been described by J. J. Schoemann (1948: 35).

For the chemical analysis 270 grammes of the rock were broken up and roughly crushed, mixed, and quartered several times, and eventually 36 grammes were ground finely for the analysis, care being taken to keep the sample thoroughly mixed during the grinding. The analysis was made by Dr. Max. H. Hey of the Department of Mineralogy, British Museum (Natural History), and I am greatly indebted to him for this important contribution to the present paper. His analysis is given in Table I, column 1, and compared with the analysis of the kenyte [GN417], referred to above, and with three previously published analyses of kenytes from Mt. Kenya.

[1] Numbers in square brackets refer to specimen numbers. G refers to J. W. Gregory's 1893 collection; GN to specimens collected by Gregory in 1919 and described by Miss A. Neilson.

TABLE I

Analyses

	1	2	3	4	5
SiO_2	55·48	52·10	53·98	53·80	54·53
TiO_2	0·70	0·30	0·57	0·31	0·98
Al_2O_3	18·70	22·29	19·43	18·46	19·48
Fe_2O_3	3·53	1·73	4·39	6·22	1·18
FeO	2·08	4·10	2·05	0·40	5·72
MnO	0·12	0·23	0·26	0·33	0·12
MgO	1·75	1·17	1·07	1·05	1·44
CaO	2·17	2·42	2·04	2·53	2·28
Na_2O	7·04	8·60	8·81	7·09	9·16
K_2O	4·85	4·66	5·27	5·46	4·80
H_2O+	3·31	0·75	1·66	3·54	0·12
H_2O-	0·19	1·00	0·13	0·85	0·06
P_2O_5	0·24	0·46	0·30	0·53	0·12
Cl′	tr.	n.d.	n.d.	n.d.	tr.
CO_2	nil	n.d.	n.d.	n.d.	nil
Totals	100·16	99·81	99·96	100·57	99·99
NORMS					
or	28·64	27·80	31·14	32·80	28·36
ab	39·82	25·68	26·46	32·49	23·53
an	5·00	8·34	—	1·95	—
ne	10·65	25·56	23·71	15·05	26·90
ac	—	—	3·70	—	3·42
di	3·24	—	6·64	5·40	8·99
ol	1·99	6·31	0·14	—	6·10
mt	5·05	2·55	4·64	1·62	—
il	1·32	0·61	1·06	0·61	1·85
ap	0·57	1·34	0·67	1·34	0·27
hm	0·05	—	—	5·12	—
ns	—	—	—	—	0·08
'NIGGLI VALUES'					
si	183	154	165	175	160
al	36	39	35	35	34
fm	23	19·5	21	22	24
c	8	7·5	7	9	7
alk	33	34	37	34	35
ti	1·8	0·7	1·3	0·8	2
k	0·31	0·26	0·28	0·33	0·27
mg	0·37	0·26	0·23	0·23	0·26
c/fm	0·35	0·38	0·32	0·39	0·31
qz	−49	−82	−77	−61	−77

1. Phonolite (Kapiti type), I(II).6.1(2).4. 12 miles NE. of Kajiado Station, Kenya Colony. M. H. Hey anal. [B.M. 1947, 200 (1).]

2. Kenyte, 'Phonolite of Kapitian type'; Neilson, 1921, I(II).6.(1)2.4. North-east of Amboni River, Meru road, Kenya. W. H. Herdsman anal. [GN417.]

3. Kenyte, II.6.1.4. From the central core of Mt. Kenya, above Lewis glacier, Teleki Valley. G. T. Prior anal. [G499.] (Gregory, 1900: 209; Prior, 1903: 247; Washington, 1917: 561.)

4. Kenyte, (I)II.'6.1.'4. Lava-flow from the summit of Mt. Höhnel, Mt. Kenya. G. T. Prior anal. [G462.] (Prior, 1903: 247; Washington, 1917: 561.)

5. Phonolite-obsidian, II.6.1.4. Campi Sheitani, above the Mackinder Valley (13,000 ft.), Mt. Kenya. M. H. Hey anal. [B.M. 1948, 195.]

The kenyte represented by the analysis in column 4 [G462] has a brown, glassy, opaque groundmass and the marked preponderance of Fe_2O_3 and high content of H_2O were regarded as due to the state of alteration of the rock. If this analysis (col. 4) be left out of consideration one finds that the new analysis of the phonolite (Kapiti type) differs from the kenyte analyses only very slightly. SiO_2 is higher (1·5–3·4); MgO and TiO_2 are very slightly higher; Na_2O and Al_2O_3 are slightly lower; and so are total iron oxides and MnO. The only really notable difference is the high percentage of H_2O lost at above 105° C.: 3·31 per cent. compared with 1·66 per cent. in the kenyte (col. 3).

The higher SiO_2 and lower Al_2O_3 and Na_2O in the analysis of the Kapiti phonolite result in a lower percentage of nepheline (*ne*) in its norm than in the norms of the kenytes, but in thin sections there is more visible nepheline in the Kapiti phonolites than in the kenytes. The higher H_2O content of the Kapiti phonolite is, however, accounted for, at least in part, by conspicuous interstitial analcime and by zeolites (natrolite partly) both in the groundmass and in small amygdules. Apart from the presence of this easily visible analcime there is very little difference in the mineral composition of the two types of rock. Both contain phenocrysts of anorthoclase and of nepheline, and a few microphenocrysts of a pale green pyroxene and of olivine or its pseudomorphs. As regards the groundmass the mineral components are the same in both rocks, with the exception of the analcime mentioned above and the higher proportion of nepheline in the Kapiti phonolite.

In the Kapiti phonolites feldspar laths lie at all angles (and have been recorded up to 1 mm. in length) and tend to divide the field into small triangular areas (Pl. 1, Fig. 1). The dark minerals are katophorite, aegirine, and cossyrite, the katophorite predominating. In the less fine-grained examples the soda-amphiboles occur as allotriomorphic plates between the feldspars, and the interstices between the feldspar laths are occupied by other feldspar plates and by clear colourless analcime enclosing minute idiomorphic nephelines and grains of opaque 'ore'. There are microphenocrysts of a pale green pyroxene and of olivine which in some specimens is altered to a dark green serpentine (?). The olivine is associated with small crystals of magnetite or ilmenite and stout prisms of apatite. In finer-grained specimens the nepheline seems to be represented by brownish turbid material in the interfeldspar areas, but the texture is a small-scale equivalent of that just described (Pl. 1, Fig. 3).[1]

In the kenytes the groundmass ranges from glassy (holohyaline) to crystalline with a small proportion of a colourless isotropic base which appears to be glass and not analcime. According to Gregory (1921: 146) the kenytes with the wholly glassy base are typical of the lavas around the central nepheline-syenite of Mt. Kenya. They contain large crystals of anorthoclase and 'the dark-coloured constituents are microscopic crystals or large grains of a pale green aegirine . . . often altered to . . . opacite. The other important constituent is olivine, which is often much altered.' In the specimen of which the analysis by G. T. Prior is given in column 3 the groundmass is

[1] J. J. Schoemann has described the texture of the Kapitian phonolites of the Yatta Plateau as 'usually intergranular with the felspar laths commonly in semi-trachytic alignment', and adds: 'There is much colourless often clear isotropic material with low refractive index in the interspaces or in large patches' and 'Zeolitic material is a prominent alteration product extensively replacing both phenocrysts and groundmass'. *Rep. Geol. Surv. Kenya*, **14**, 1948: 36, fig. 6*c*.

in part microspherulitic and interstitial material is a pale brown glass (Pl. 2, Fig. 2). In the better-crystallized specimens the dark minerals are cossyrite, katophorite, aegirine, and a very pale green pyroxene. The cossyrite and katophorite occur as irregular plates up to 0·04 mm. diameter cut up by minute feldspar laths (0·05–0·1 mm. long) so that the texture is micro-ophitic. The feldspar laths lie all through the soda-amphiboles and the colourless base (Pl. 2, Fig. 4). Only rarely can one detect minute nephelines in the colourless base.[1] There are microphenocrysts of nepheline, of pale green pyroxene, and of olivine which is either fresh or altered to brown iddingsite or to an opaque material, and there are stout prisms of apatite and crystals of opaque 'ore'.

The better-crystallized specimens are represented by GN417 from near Songari Hill described in the 1931 paper (Campbell Smith, 1931: 241; Analysis, Table I, col. 2) and by specimens collected by Dr. Oakley from an outcrop below Memsahib Camp, west of Ontulili Valley at about 10,500 feet [B.M. 1947, 199 (1)] and from Liki Valley, Nanyuki, on the north-west side of Mt. Kenya. The holohyaline groundmass is seen in G519 collected by Gregory from Phonolite Cwm, east-north-east of Mt. Höhnel (Campbell Smith, 1931: 244).

Comparison of the summarized descriptions of the two types shows that, as might be expected from the analyses, there is very little difference as regards mineral composition between the holocrystalline examples of the kenytes and the Kapiti phonolites. Interstitial analcime and clearly defined nepheline in the Kapiti phonolites contrast with a colourless, isotropic, and probably glass base and few nephelines (detected with difficulty) in the kenytes. Zeolites are more in evidence in the Kapiti phonolites. In the chemical analyses the analcime and zeolites of the Kapiti phonolites are reflected by the higher water-content (Table I, col. 1). Much of the normative nepheline of the kenytes must be 'occult' and must be accounted for by the colourless base, as is indicated by the staining tests.

As regards texture, so far as the limited series of specimens examined goes, there seems to be a distinction. The Kapiti phonolites are holocrystalline with interstitial areas of analcime and small nephelines between the long feldspar laths; the kenytes, apart from those with a wholly glassy or partly glassy and sometimes microspherulitic groundmass, are commonly micro-ophitic with very short, slender feldspar laths and a colourless, apparently glassy base.

Turning now to the hand-specimens of the rocks one gets an impression that feldspar phenocrysts are more abundant and nepheline phenocrysts relatively scarce and more difficult to detect in the kenytes than in the Kapiti phonolites.[2] The groundmass colour is deep to blackish mouse-grey in the kenytes and a shade greener in the Kapiti phonolites, grading to dark olive-grey in the less fine-grained specimens.

Such differences in the macroscopic and microscopic characters as these are slight distinctions difficult to introduce in definitions of the two rock-types, nor, until a far

[1] After being treated with conc. HCl for 2 minutes much of the colourless base stains with malachite-green and is, therefore, probably nepheline. P. Marshall has given reasons for regarding the interstitial colourless material in some phonolites, called by Rosenbusch and others 'phonolite-glass', as zeolite (1947: 41).

[2] Schoemann estimates the phenocrysts and amygdules in the Yatta Plateau phonolites at 20–30 per cent. with nepheline : feldspar about 1 : 4. *Rep. Geol. Surv. Kenya*, **14**, 1948: 36.

more extensive suite of rocks has been examined, could one tell whether they are distinctions of general application and of diagnostic value.

Already one may note that Schoemann describes the feldspar laths in the Yatta Plateau phonolites (Kapitian) as 'commonly in semi-trachytic alignment' (footnote p. 6), and Shackleton records a non-porphyritic fissile phonolite in the Mt. Kenya Volcanic Suite with 'microphenocrysts of anorthoclase in a dark base of mossy aegirine and cossyrite, clearer areas of alkali felspar, minute nephelines, and analcite'.[1] However, the fact remains that the kenytes of the Mt. Kenya Volcanic Suite and the Kapiti phonolites are not only stratigraphically distinct but are easily distinguished in the field. Shackleton (1945: 16) writes: 'The kenytes are distinguished in the field by their very abundant large anorthoclase crystals, usually of the rhombic habit, and fewer greenish nephelines, in a dark grey non-fissile base. Weathering to very large rough masses, round rather than angular, is highly characteristic (and entirely different from the slabby outcrops of the fissile Kapiti phonolite, or any of the other plateau phonolites).'

It seems as if the farther one gets from the microscope the less alike do the kenytes and Kapiti phonolites appear. The names were first given in the field and they are names of great utility in Kenya Colony. It is not for the petrographer to attempt to destroy them, but he may be allowed to give a warning that the difference between them is a slender one.

If, as P. Marshall suggests, the colourless interstitial material in many phonolites is not 'phonolite-glass' but zeolite, the mineralogical difference is reduced to merely one of recognizable analcime in the Kapiti phonolites and a smaller percentage of unresolvable, possibly zeolitic, colourless material in the groundmass of the kenytes.

It would have been as well if the names had not been applied to any rocks outside Kenya Colony; indeed, Kapitian phonolite (with one exception) has not. Kenyte, however, has been applied to rocks on Kilimanjaro and on and around Mt. Erebus in South Victoria Land which resemble rather closely the kenytes of Mt. Kenya, but it has been applied also to other rocks not so like. The limits within which the names kenyte and Kapiti phonolite should be used need to be carefully considered by petrographers who have studied these rocks in the field as well as under the microscope.

It may be advisable to restrict the name 'kenyte' to rocks like those round the central plug of Mt. Kenya (to which Gregory first gave the name) in which large crystals of anorthoclase (and nepheline more rarely) lie in a black, glassy base. These rocks could probably be so defined as not to exclude the somewhat similar rocks from Kilimanjaro and Mt. Erebus, especially if the name is to be used mainly (or only) as a field name. Such a limitation of the name 'kenyte' to those with obviously glassy base would exclude those variations with crystalline groundmass which we have seen to resemble so closely the Kapitian phonolites. For these and for the Kapiti phonolites a single descriptive name is needed such as 'porphyritic (anorthoclase-) phonolite' followed by some distinguishing 'type' name which will not imply connexion with either the Mt. Kenya Volcanic Suite or the Kapitian Series. If the analcime so frequently observed in the Kapiti phonolites proves to be generally

[1] Other non-porphyritic phonolites on Mt. Kenya were recorded by Gregory and described by Prior as phonolite (Kenya type). (Prior, 1903: 239.)

present and to be a distinguishing feature it could be introduced in the descriptive name where appropriate.

In chemical composition the kenytes and Kapiti phonolites are not only like each other but they are also rather similar to phonolites (Kenya type) from Mt. Kenya and from Kisumu, and it appears, therefore, that there is very little difference in the composition between the lavas of the Mt. Kenya Volcanic Suite and those of the earlier Kapitiàn Series. May it be that more magmatic water was held by the Kapitian phonolites than by the lavas erupted at Mt. Kenya? If so, the higher water-content may have so reduced the viscosity of the Kapitian phonolites that they were able to spread over the Kapiti Plains and the Yatta Plateau, while a similar magma but with less water retained resulted in the more viscous and perhaps more quickly solidifying lavas of Mt. Kenya. Some support for the suggestion that the water content of the lavas of Mt. Kenya may have been very low is afforded by a new analysis of a phonolite-glass found by Dr. F. E. Zeuner as fragments lying among loose crystals of anorthoclase and acting as a matrix for rough agglomerations of these crystals, at Campi Sheitani, above the Mackinder Valley (13,000 ft.) on Mt. Kenya. The analysis of this glass made for me by Dr. Max. H. Hey is quoted in Table I, column 5. It shows only 0·12 per cent. of water lost at above 105° C. This, however, is at present an isolated example. Other lavas from Mt. Kenya show water contents varying from 0·98 to 1·66 per cent. The glassy lavas of the central plug and higher parts of Mt. Kenya have not been investigated in any detail. There is a field here for much further work when material is available.

It may be possible to show what relation there is between the composition of the glass collected by Dr. Zeuner and the composition of other glassy kenytes with their associated phenocrysts and of the other lavas of Mt. Kenya. Through this study also one may find the explanation of the loose crystals of anorthoclase lying around the old crater so similar in mode of occurrence to the potash-oligoclase crystals that strew the slopes of Mt. Erebus in South Victoria Land.

Description of the Analysed Specimen of Kapiti Phonolite [B.M. 1947, 200 (1)]

Megascopic characters. Holocrystalline, porphyritic with feldspar insets up to 2·5 cm. long and, less frequent, hexagonal nephelines, sometimes 1·5 cm. across. The groundmass is compact, clearly crystalline, and dark olive-grey in colour. Some microphenocrysts, up to 2 mm., of a black mineral prove to be pyroxene. There are rare, compact white patches of zeolite some of which are 0·5 mm. across, but those more generally distributed through the rock are small (1–2 mm.) amygdules. The zeolite filling them is natrolite.

The feldspar phenocrysts are simple Carlsbad twins showing in some sections rather indefinite twin lamellae resembling albite twins but not showing the very fine-scale twinning so often seen in anorthoclase. On a (010) cleavage flake, extinction with reference to a second cleavage was measured as $7\frac{1}{2}°$, and refractive indices in sodium light as α 1·527, β 1·533. These values are rather close to those given by E. D. Mountain (1925: 336) for the loose feldspar crystals collected by J. W. Gregory (1900: 216) on the slopes of the crater of Mt. Kenya in 1893, which were shown to

have the composition $Or_{27}Ab_{63}An_{10}$ and to fall within anorthoclase as defined by H. L. Alling (1921: 253).

The pyroxene microphenocrysts are rather rare; only one was seen in a section 3×2 cm. The colour is very pale greyish-green in thin section and the pleochroism is very weak. $Z \wedge c$ in one section gave 48°.

The nepheline has refractive index in Na-light, $\omega = 1{\cdot}5335 \pm 0{\cdot}0005$. This is near that of the nepheline phenocrysts in the kenytes (Campbell Smith, 1931: 245).

Microscopic characters. The texture of the groundmass somewhat resembles that texture of basalts described as intersertal. Laths of a feldspar up to 0·6 mm. in length and averaging 0·04 mm. in width lie at all angles and tend to divide the field into small triangular areas occupied by plates of feldspar, brown katophorite, and darker, nearly opaque cossyrite, small amounts of aegirine, minute crystals of opaque 'ore', nepheline (mostly turbid and inclusion-rich), and colourless isotropic analcime enclosing smaller nephelines (Pl. 1, Figs. 1 and 2).

Some of the nepheline, particularly that enclosed in analcime, is quite clear, but most of the material filling the inter-feldspar areas is turbid (some shows hexagonal form) and in some crystals radiating or sheaf-like fibres of zeolite have been formed. The zeolite is probably natrolite as in the amygdules. The isotropic interstitial material identified as analcime gave no reaction for Cl′. After etching with HCl it stains less readily than the nepheline.[1] A micrometric analysis of a stained section indicated about equal proportions of nepheline as recognizable crystals and isotropic base (analcime).

The feldspar laths are simple (Carlsbad) twins and mostly give straight extinction, though one as high as 7° was observed. Measurements of these crystals on the universal stage prove that the plane of the optic axes is nearly perpendicular to (010) and Z (γ) is inclined to the normal to 010 at an angle of 5° to 8°. X (α) is inclined to the *a*-axis at about 8°. (–)2V = 42°–48°. These properties agree with those of anorthoclase. Of the dark minerals the most abundant is a rather pale-brown amphibole referred to in previous descriptions of the East African phonolites as katophorite. The mineral is strongly pleochroic giving in thin section, X pinkish-buff (17″d), warm buff (17′d), Y russet (13′k), Z near Dresden brown.[2] The maximum extinction measured was $Z \wedge c = 34°$. At edges this amphibole grades off into a greener amphibole (Z olive-green). This olive-green amphibole forms occasional microphenocrysts. One or two were found on picking over powdered material and gave $Z' \wedge c = 10\frac{1}{2}°$ on a prismatic cleavage fragment. Refractive indices were measured by the Becke line method as α 1·651±0·001, $\beta < 1{\cdot}655$, $\gamma > 1{\cdot}664$, X′ straw-yellow (21d), Z′ olive-green (23m).

Crystals, in part very dark-brown like iddingsite, in part deep-green and serpentine-like in appearance, are thought to be altered iron-rich olivine. They are associated with good crystals of an iron 'ore' with square and triangular sections, perhaps magnetite. Apatite forms stout prisms associated with the altered olivines. Similar altered olivines are present in the specimen from the Yatta Plateau referred to above

[1] This agrees with G. W. Tyrrell's recent observation on the recognition of analcime and nepheline in rock sections. *Trans. Geol. Soc. Glasgow*, **21**, 1948: 162.

[2] Ridgway, R. 1912. *Color Standards and Color Nomenclature*, Washington.

[B.M. 1915, 193 (12)]. J. J. Schoemann observed the same kind of pseudomorphs and refers them to olivine altered to 'grass-green chlorite (? antigorite) and calcite'. These pseudomorphs occur as microphenocrysts up to 0·75 mm. diameter.

Additional Note

The specimen collected by Dr. Oakley from Cairn Hill [B.M. 1947, 200 (3)] contains some large phenocrysts of anorthoclase (up to 3 cm. long) but also many smaller feldspars (1–4 mm.) which are simple Carlsbad twins and appear to be orthoclase. One hand-specimen shows a phenocryst of nepheline 1·5 cm. across and a few small nepheline phenocrysts are seen in thin sections. The larger, feldspar phenocrysts show inclusions of, or are deeply embayed by, the groundmass. Amygdules up to 0·5 cm. across are frequent in this rock.

The groundmass is fine-grained and for the most part turbid. It consists of long, thin, and sometimes slightly curved laths of feldspar with inter-feldspar areas (dominantly triangular patches) consisting of brownish turbid material, probably altered nepheline, and isotropic analcime with scattered brown amphibole and aegirine. Where the groundmass is clear it can be seen to represent a fine-scale equivalent of the groundmass of the more coarse-grained type described above. The pale-green pyroxene appears in the groundmass and occasionally as microphenocrysts. There are stout prisms of apatite sometimes in clusters, with opaque black 'ore' and possibly also cossyrite. The feldspar laths run up to 0·4 mm. in length and average about 0·01 mm. in thickness. Fine-grained variations of this kind were also described by me (1931: 238) from specimens collected by Gregory in 1893 from Ol Doinyo Sapuk [G575] and from the plains south-east of Marungu on the north bank of the Tana near its junction with the Thika river [G552, 553, 556]. In these last the feldspar laths tend to adopt an approximately parallel alinement, and 'with minute idiomorphic nephelines, lie in a colourless isotropic base which is probably analcime' (Pl. 1, Fig. 4).

REFERENCES

Alling, H. L. 1921. The mineralography of the feldspars, Part 1. *J. Geol.* **29**: 193–294.

Gregory, J. W. 1896. *The Great Rift Valley.* London.

—— 1900. Contributions to the geology of British East Africa.—Part II. The geology of Mt. Kenya. *Quart. J. Geol. Soc. London,* **56**: 205–222.

—— 1921. *The Rift Valleys and Geology of East Africa.* London.

Marshall, P. 1947. Zeolite minerals as original components of igneous rocks. *N.Z. J. Sci. Tech.* **28** [for 1946] (1) (Sec. B): 37–52.

Mountain, E. D. 1925. Potash-oligoclase from Mt. Erebus, Antarctic, and anorthoclase from Mt. Kenya, East Africa. *Min. Mag.* **20**: 331–345.

Prior, G. T. 1903. Contributions to the petrology of British East Africa. *Min. Mag.* **13**: 228–263.

Schoemann, J. J. 1948. A geological reconnaissance of the area west of Kitui township. *Rep. Geol. Surv. Kenya,* **14**: 1–43.

Shackleton, R. M. 1945. Geology of the Nyeri area. *Rep. Geol. Surv. Kenya,* **12**: 1–26.

Smith, W. Campbell. 1931. A classification of some rhyolites, trachytes, and phonolites from part of Kenya Colony, . . . *Quart. J. Geol. Soc. London,* **87**: 212–258.

Washington, H. S. 1917. Chemical analyses of igneous rocks. *U.S. Geol. Surv. Prof. Paper* No. 99.

PLATE 1

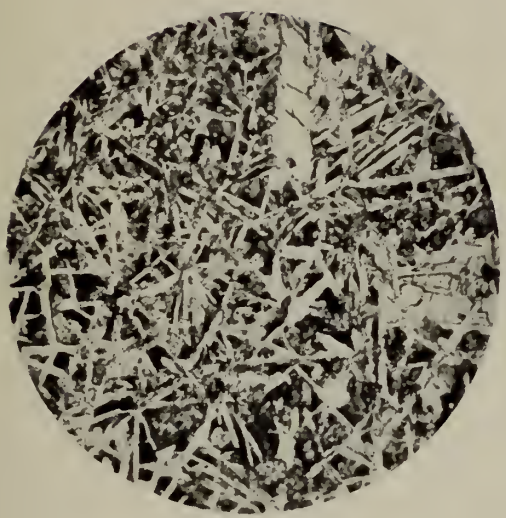
(*Photomicrographs by Mr. D. L. Williams, Dept. of Mineralogy.*)

FIG. 1. Kapiti phonolite [B.M. 1947, 200 (1)]. 12 miles NE. of Kajiado Station. ×23. (See p. 6.)

FIG. 2. The same as above. Showing hexagonal crystals of nepheline in analcime areas between feldspar laths. ×84. (See p. 10.)

FIG. 3. Kapiti phonolite [B.M. 1947, 200 (3)]. Near Cairn Hill, 6 miles ENE. of Kajiado Station. A finer grained specimen than the above. ×23. (See p. 6.)

FIG. 4. Kapiti phonolite [B.M. 1921, 536 (225) = G552]. 'Steppes of the Kiroruma, camp at "Marungu" ' (1893); '(the unnamed 3,837 ft. hill, at 37° 19′ E., 0° 46′ S. on the G.S., G.S. map, sheet Kenya, 1912).' (Gregory, 1921: 157; Campbell Smith, 1931: 239). Shows trachytic alinement of feldspar laths in the groundmass of soda-amphiboles and pyroxene, and turbid, colourless minerals. The large crystal is apatite. ×60. (See p. 11.)



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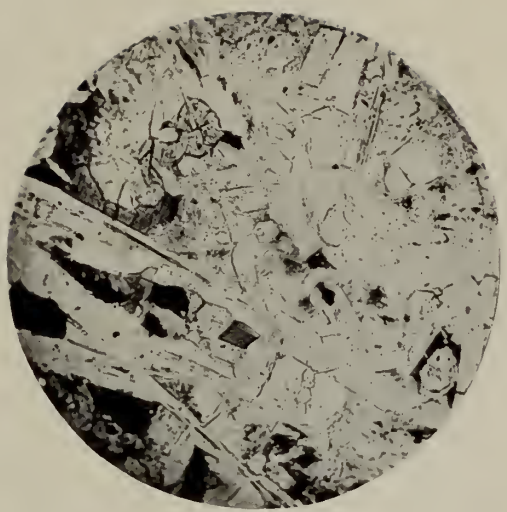

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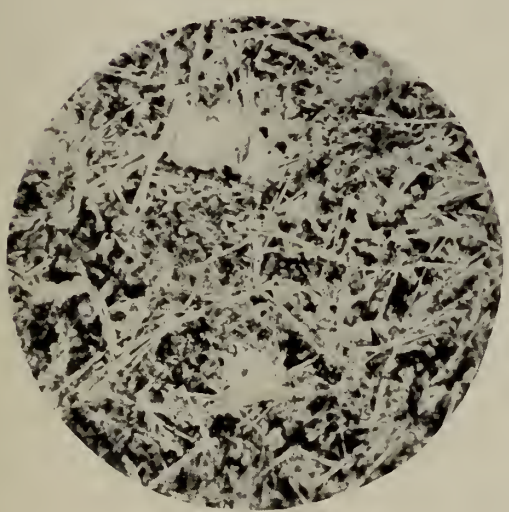

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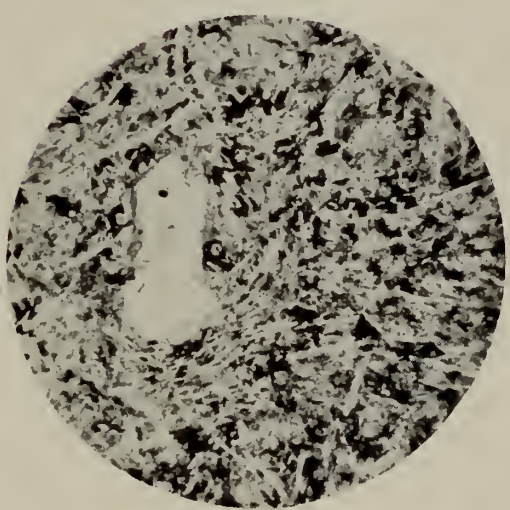


4

KAPITI PHONOLITES FROM KENYA COLONY

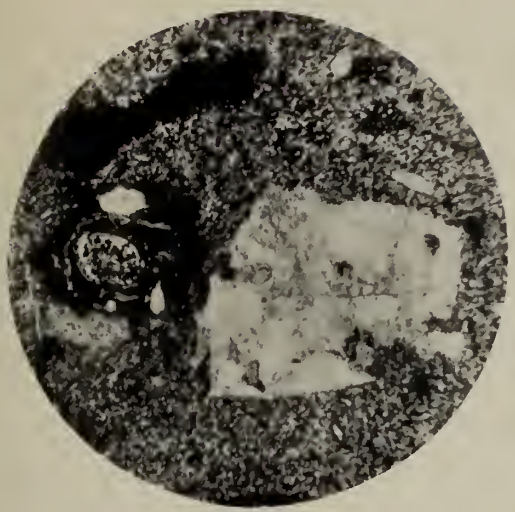
PLATE 2

FIG. 1. Kenyte [B.M. 84757, 27 = G499]. From the central plug of Mt. Kenya, Teleki Valley. ×23. Part of the area of Gregory's original section figured by him. (1900, pl. xi, fig. 1.) The large white crystal is nepheline (*not* anorthoclase). Also shown: altered olivine, prisms of apatite, and groundmass of soda-amphiboles, &c., and feldspar laths in colourless base. (See p. 6.)

FIG. 2. Kenyte [B.M. 84757, 13 = G462]. Lava-flow, summit of Mt. Höhnel, Mt. Kenya. Elongated vesicles lined with brown glass (at the top). Texture in parts microspherulitic. The crystal (bottom left) is feldspar. ×23. (See p. 7.)

FIG. 3. Kenyte [G499]. The groundmass of the specimen figured in Fig. 1. ×60. (See p. 6.)

FIG. 4. Kenyte (previously described as phonolite of Kapiti type) [B.M. 1930, 380 (9) = GN417]. NE. of Amboni River, 7 miles NNE. of Nyeri. Showing groundmass. Cossyrite, katophorite, and pyroxene as irregular plates, with feldspar laths, in colourless base. ×60. (See p. 7.)



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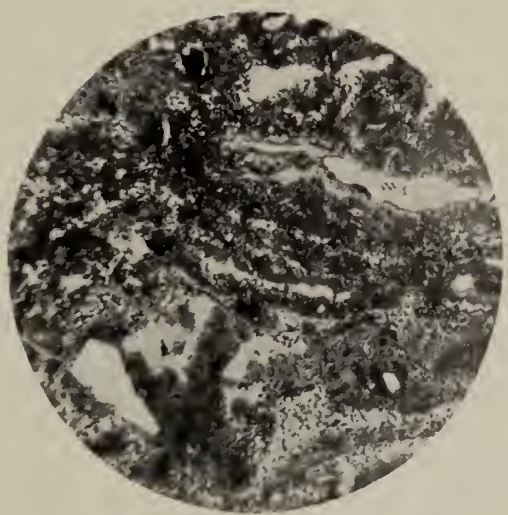

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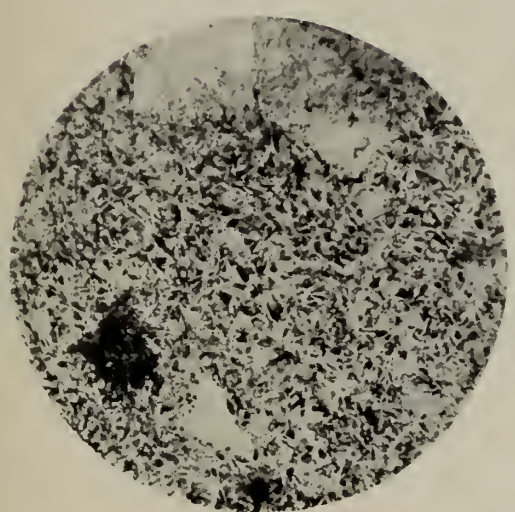

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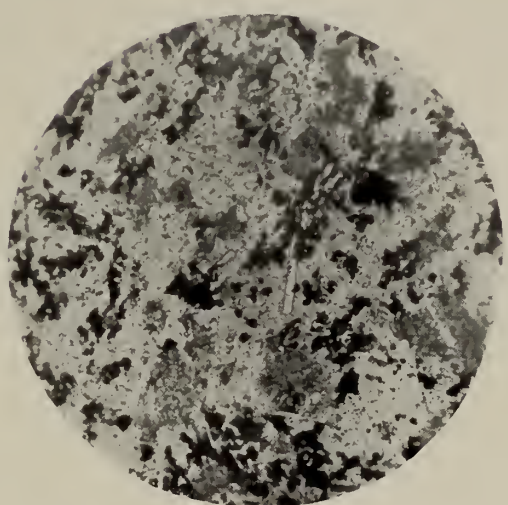

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KENYTES FROM KENYA COLONY